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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/707,726	01/07/2004	Toshiharu Furukawa	FIS920030316US1	1725
32074	7590	11/30/2004	EXAMINER	
INTERNATIONAL BUSINESS MACHINES CORPORATION DEPT. 18G BLDG. 300-482 2070 ROUTE 52 HOPEWELL JUNCTION, NY 12533			HU, SHOUXIANG	
			ART UNIT	PAPER NUMBER
			2811	
DATE MAILED: 11/30/2004				

Please find below and/or attached an Office communication concerning this application or proceeding.

**Office Action Summary**

Application No.

10/707,726

Applicant(s)

FURUKAWA ET AL.

Examiner

Shouxiang Hu

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --  
Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

**Status**

- 1) ☒ Responsive to communication(s) filed on 03 September 2004.
- 2a) ☐ This action is FINAL. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

**Disposition of Claims**

- 4) ☒ Claim(s) 1-20 is/are pending in the application.
- 4a) Of the above claim(s) 17-20 is/are withdrawn from consideration.
- 5) ☐ Claim(s) \_\_\_\_\_ is/are allowed.
- 6) ☒ Claim(s) 1-16 is/are rejected.
- 7) ☐ Claim(s) \_\_\_\_\_ is/are objected to.
- 8) ☐ Claim(s) \_\_\_\_\_ are subject to restriction and/or election requirement.

**Application Papers**

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on \_\_\_\_\_ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.  
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).  
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

**Priority under 35 U.S.C. § 119**

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some \* c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
  2. ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_\_.
  3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

\* See the attached detailed Office action for a list of the certified copies not received.

**Attachment(s)**

- |  |   |
|--|---|
| 1) <input checked="" type="checkbox"/> Notice of References Cited (PTO-892)  | 4) <input type="checkbox"/> Interview Summary (PTO-413)<br>Paper No(s)/Mail Date. _____ |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948)                                   | 5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152)             |
| 3) <input type="checkbox"/> Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)<br>Paper No(s)/Mail Date _____ | 6) <input type="checkbox"/> Other: _____  |

## DETAILED ACTION

### *Election/Restrictions*

1. Claims 17-20 are withdrawn from further consideration pursuant to 37 CFR 1.142(b) as being drawn to a nonelected invention, there being no allowable generic or linking claim. Election was made **without** traverse in the reply filed on September 03, 2004.

### *Claim Rejections - 35 USC § 112*

2. The following is a quotation of the first paragraph of 35 U.S.C. 112:

The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same and shall set forth the best mode contemplated by the inventor of carrying out his invention.

Claims 6, 7, 11, 12, 15 and 16 are rejected under 35 U.S.C. 112, first paragraph, as failing to comply with the written description requirement. The claim(s) contains subject matters which were not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventor(s), at the time the application was filed, had possession of the claimed invention. These claims recite the subject matters of "introducing a chemical constituent into the nanotube material during formation of one of the top and bottom of the nanotube to produce an electrical effect during operation", which are critical or essential to the practice of the invention as defined in these claims. However, the disclosure lacks an adequate description regarding what is the recited chemical constituent; how it is introduced into the recited

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naotube's bottom and top sections inside the recited aperture; and how such process steps could be controllable.

***Claim Rejections - 35 USC § 102***

3. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

4. Claims 1-4, 8, 9 and 13 are rejected under 35 U.S.C. 102(e) as being anticipated by Roesner et al. ("Roesner"; US 6,740,910).

Roesner discloses a method of forming a vertical field effect transistor having a channel a carbon nanotube (see Figs. 1A-1C), comprising the steps of: forming a first conductive layer (102) on a substrate (101); forming a first insulating layer (103); forming a gate layer (104); forming an aperture (106), having substantially vertical interior walls, through the gate layer and the first insulating layer, the bottom of the aperture exposing the first conductive layer; forming an insulating liner (109) on the walls of the aperture; forming a catalyst (107); forming a semiconductive carbon nanotube (108) in the aperture, the bottom of the carbon nanotube being in electrical contact with the first conductive layer; and forming an electrical contact (110) on a top of the carbon nanotube.

Regarding claim 2, the method of Roesner including forming at least two FETs in a row.

Regarding claims 4, 8 and 13, the liner ---the gate insulating layer (109) in Roesner is formed thorough oxidation of the gate layer material (see col. 6, lines 24-31); and such a oxidation process step naturally involves an temperature-elevated environment.

### ***Claim Rejections - 35 USC § 103***

5. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

Claims 5-7, 10-12 and 14-16, insofar as being in compliance with 35. U.S.C. 112, are rejected under 35 U.S.C. 103(a) as being unpatentable over Roesner.

The disclosure of Roesner is discussed as applied to claims 1-4, 8, 9 and 13 above.

Although Roesner does not expressly disclose that: the insulating liner can be formed through CVD as recited in claims 5, 10 and 14; and/or that the channel forming nanotube can include LDD-type portions through changing the chemical compositions, one of ordinary skill in the art would readily recognize that such insulating liner functions as a gate insulating layer, which can also be readily formed through CVD for obtained good gate dielectric property, as evidenced in the prior art such as Yang (US 6,033,941;

see col. 1, lines 41-45), and/or Fitch et al. (US 5,414,289; see col. 4, lines 2-12); and that such LDD portions can desirably formed in FET for improving the channel performance therein, as further evidenced in Fitch et al. (see the LDD regions 27 and 32 in the cover page figure).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to make a vertical FET using the method of Roesner with the insulating liner being formed through CVD and/or with LDD portions being introduced into the nanotube, so that a method for forming a vertical FET with good quality on the gate insulating layer and/or with improved channel performance would be obtained.

### ***Conclusion***

6. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure. References B-F are cited as being related to a device structure and/or a material set for a FET.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Shouxiang Hu whose telephone number is 571-272-1654. The examiner can normally be reached on Monday through Thursday, 7:30 AM to 6:00 PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Eddie C. Lee can be reached on 571-272-1732. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

SH  
November 24, 2004



**SHOUXIANG HU**  
**PRIMARY EXAMINER**